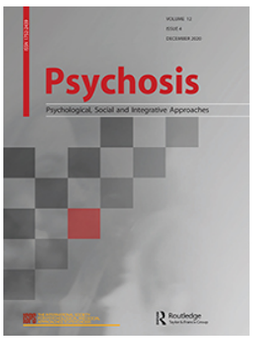

Routledge
Taylor & Francis Group

Psychosis

Psychological, Social and Integrative Approaches

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/rpsy20

Risk factors associated with general and specific dimensions of psychosis in a nationally representative sample of adults from the United States

David Murphy, Frédérique Vallières, Jamie Murphy, Eoin McElroy & Philip Hyland

To cite this article: David Murphy, Frédérique Vallières, Jamie Murphy, Eoin McElroy & Philip Hyland (2020) Risk factors associated with general and specific dimensions of psychosis in a nationally representative sample of adults from the United States, Psychosis, 12:4, 303-313, DOI: 10.1080/17522439.2020.1791238

To link to this article: https://doi.org/10.1080/17522439.2020.1791238

PSYCHOSIS
2020, VOL. 12, NO. 4, 303–313
https://doi.org/10.1080/17522439.2020.1791238

Routledge
Taylor & Francis Group

Risk factors associated with general and specific dimensions of psychosis in a nationally representative sample of adults from the United States

David Murphy[a], Frédérique Vallières[a], Jamie Murphy[b], Eoin McElroy[c] and Philip Hyland[a,d]

[a]Trinity Centre for Global Health, Trinity College Dublin, Dublin, Ireland; [b]School of Psychology, Ulster University, Coleraine, Northern Ireland; [c]Department of Neuroscience, Psychology and Behaviour, University of Leicester, University of Leicester, Leicester, England; [d]Department of Psychology, Maynooth University, Kildare, Ireland

ABSTRACT

General and specific dimensions of psychosis have been identified in both clinical and general population samples. Demographic and clinical correlates, however, have only been explored within models derived from clinical data. Data were drawn from Wave 3 of the National Epidemiological Survey on Alcohol and Related Conditions (N = 36,309). Confirmatory factor analysis and confirmatory bifactor modelling were used to determine the optimal measurement model of psychosis symptoms among this sample. Structural equation modelling was used to identify variables correlated with the different psychosis dimensions, as per the best fitting measurement model. Measurement modelling results indicated that the latent structure of psychosis was best represented by a bifactor model including a general dimension orthogonal to four specific dimensions representing "Positive", "Negative", "Mania", and "Disorganized" symptoms. Childhood interpersonal trauma, lack of social support, lower socio-economic status and suicidal attempts were associated with higher scores on the general dimension. These results provide further support for the validity of a bifactor model of psychosis in the general population and identify unique risk correlates of specific and general factors of psychosis.

ARTICLE HISTORY
Received 5 May 2020
Accepted 30 June 2020

KEYWORDS
Psychosis; bifactor modelling; general symptom dimension; specific symptom dimension

Dimensional representations of psychiatric phenomena including psychosis are beginning to offer alternative opportunities to consider clinical assessment, aetiology and intervention (Hengartner & Lehmann, 2017; Kotov et al., 2018; Potuzak et al., 2012; Widiger & Gore, 2014). Contrary to current diagnostic manuals reflecting a traditional Kraepelinian dichotomy between affective and non-affective psychosis, research demonstrates that psychotic symptoms are best represented by a "bifactor pentagonal" model (Reininghaus et al., 2016, 2013). The bifactorial pentagonal model includes a general psychosis dimension that accounts for the common variance shared among all symptoms and five specific dimensions that partition the remaining variance into (i) positive, (ii) negative, (iii) depressive, (iv) manic, and (v) disorganized symptoms. Recent findings indicate that ethnic minority status, urbanicity, impaired social functioning, older age, and sex are differentially associated with the general and specific dimensions of psychosis (Quattrone et al., 2019; Reininghaus et al., 2019).

However, the literature has primarily focussed on clinical samples when assessing the bifactor pentagonal model. Using data sourced from the second version of the National Epidemiological

CONTACT David Murphy murphd71@tcd.ie Trinity Centre for Global Health, Trinity College Dublin, Dublin, Ireland
Supplemental data for this article can be accessed here.

Survey on Alcohol and Related Conditions (NESARC-II) in the United States (US.), Shevlin et al. (2016) found that the bifactorial pentagonal model of psychosis also provided an excellent representation of the general population data. However, an extremely high correlation (r =.99) existed between the "Negative" and "Depressive" dimensions calling into question the validity of the distinction between these dimensions. In addition, there remains a dearth of understanding as to how other risk-variables for psychosis such as childhood interpersonal trauma (Bonoldi et al., 2013; Fusar-Poli et al., 2017; Varese et al., 2012) diminished social support (Crush et al., 2018; Gayer-Anderson & Morgan, 2013), and suicidality (Murphy et al., 2018) are associated with dimensions of psychosis identified within the bifactor pentagonal model of psychosis. Identifying exogenous risk factors associated with the general and specific dimensions is particularly important given Greene et al.'s (2019) recent recommendations regarding the overreliance on model fit estimates when assessing bifactor models of psychopathology.

Given the strength of evidence in support of the bifactorial pentagonal model of psychosis, it is important to continue to explore how the general and specific dimensions of psychosis vary in relation to a broad array of recognised risk factors. Thus, this study was conducted with three objectives in mind. First, to test the validity of the bifactorial pentagonal model of psychosis in a nationally representative sample of US. adults. Specifically, we sought to determine if the findings of Shevlin et al. (2016) could be replicated using the third version of the NESARC study. Second, we sought to test the reliability and replicability of the general and specific dimensions of psychosis by following the guidelines set forth by Rodriguez et al. (2016). Third, in line with Greene et al.'s (2019) recommendations, we sought to examine associations between identified dimensions in the best fitting model and an array of risk variables including age, sex, socio-economic status, ethnic minority status, urbanicity, childhood interpersonal trauma, social support, and history of suicidal attempt. Based on the assumption that the general and specific dimensions of psychosis represent reliable, replicable, and valid constructs, we hypothesised that each psychosis dimension would be significantly associated with at least one exogenous risk factor and that a significant proportion of variance in each psychosis dimension would be accounted for by these risk factors.

Method

Participants and procedures

Data were drawn from the NESARC-III dataset (Grant et al., 2014) which is representative of the civilian, non-institutionalized adult population of the US, including residents of the District of Columbia, Alaska, and Hawaii. Data were collected between 2012 and 2013 (N = 36,309). The NESARC-III employed multistage probability sampling methods to randomly select one participant from households and designated group dwellings (Grant et al., 2014). Higher probability rankings were allocated to minority homes (i.e., Black, Hispanic, Asian) to ensure their inclusion within the survey. As such, two prospective respondents were randomly selected from minority households with more than four adults. The initial screener response rate was 72.0% with an overall response rate of 60.1% (Grant et al., 2014). To ensure representativeness, the data were adjusted and weighted to counterbalance oversampling and non-responses. Data were collected electronically via face-to-face structured interviews delivered by trained laypersons. More specific details about the sampling procedures for NESARC-III are described elsewhere (see Grant et al., 2014). The demographic details of the NESARC-III sample are presented in Table 1.

Measures

Data were collected using the Alcohol Use Disorder and Associated Disabilities Interview Schedule-5 (AUDADIS-5; Grant et al., 2011). This scale captures a multitude of psychiatric diagnoses in accordance with DSM-5 criteria and has been shown to provide valid and reliable measures of substance abuse and psychiatric disorders (Grant et al., 2015; Hasin et al., 2015). The AUDADIS-5 is a slight

Table 1. Weighted sociodemographic characteristics of the sample (N = 36,309).

	% (n)
Sex	
Male	43.7 (15,862)
Female	56.3(20,447)
Age in Years	
18–29	22.4% (8126)
30–44	27.9% (10,135)
45–59	26.7% (9681)
60+	23.0% (8367)
Race/Ethnicity	
White, Non-Hispanic	52.9% (19,194)
Black, Non-Hispanic	21.4% (7766)
American Indian/Alaska Native, Non-Hispanic	1.4% (511)
Asian/Native Hawian/Pacific Islander, Hispanic	5.0% (1801)
Hispanic, any race	19.4% (7037)
Urbanicity	
Urban	83.2% (30,193)
Rural	16.8% (6116)
Income, US$	
Median and above ($30,000–34,000 to $100,000+)	37.9% (13,765)
Below the median ($0.00 to 25,000 – $29,000)	62.1% (22,544)

variation of the AUDADIS-IV (AUDADIS-IV; Grant & Dawson, 2000) which was used in NESARC-I and NESARC-II to measure psychiatric diagnoses in accordance with the DSM-IV guidelines (Grant et al., 2003; Ruan et al., 2008). Given that the first objective of the current study was to replicate the findings of Shevlin et al. (2016) using the NESARC-III data, we followed the same procedures outlined by these authors to select the corresponding items from the AUDADIS-5.

Psychosis symptoms

Shevlin et al. (2016) selected 22 items from various sections of the AUDADIS-IV to approximate the spectrum of psychosis symptoms. Specifically, they selected items conceptually similar to those within the Positive and Negative Syndrome Scale (PANSS; Kay et al., 1987) and items that mirrored those used by Reininghaus et al. (2013). As the AUDADIS-5 differs slightly from the AUDADIS-IV, we selected 23 items in an attempt to capture the same psychosis symptom profile (see supplementary Table 1). In total, 13 of the 23 items were drawn from Section 10 of the AUDADIS-5 ("Usual Feelings and Actions"), six were drawn from section 4A ("Low Mood I"), two were drawn from section 5 ("High Mood"), and one item was drawn from section 9 ("General Anxiety"). For items selected from Section 10, if a specific symptom was endorsed, a follow up question was presented enquiring whether that symptom caused any distress or impairment in functioning. An indicator of psychosis was deemed to be present (scored '1') if the symptom and the distress/impairment questions were endorsed. As the other sections of the AUDADIS-5 did not include a distress/impairment follow up question, a screener question was included prior to the presentation of the remaining symptoms. For these, an indicator of psychosis was deemed to be present if the screener question and the symptom indicator were endorsed. The endorsement rates for the 23 indicators of psychosis are reported in Supplementary Table 1.

Risk variables

Childhood trauma

Section 13 of AUDADIS-5 included a measure of adverse life events that occurred prior to one's 18th birthday. These questions were based on the Adverse Childhood Experiences (ACE) study (Dong et al., 2003; Dube et al., 2003) with additional questions drawn from the Childhood Trauma Questionnaire (Bernstein et al., 1994) and the Conflict Tactics Scales (Straus, 1979; Straus et al., 1996). We selected a subset of 19 questions to reflect childhood interpersonal trauma (e.g.,

emotional neglect, physical neglect, emotional abuse, physical abuse, and sexual abuse). Respondents indicated how frequently they experienced each event on a 5-point Likert scale ranging from 1 (*Never*) to 5 (*Very often*). A summed total score of childhood interpersonal trauma was computed with higher scores indicating a higher frequency of childhood interpersonal trauma.

Social support

Section 2E included 12 questions measuring perceived social support. Respondents were asked to indicate how true or false each statement was on a 4-point Likert scale ranging from "definitely false" to "definitely true". All items were dichotomised to reflect "true" (1) or "false" (0) statements and higher scores indicated higher levels of perceived social support. The scale scores showed satisfactory internal reliability (α = .77).

Suicide

A history of attempted suicide was measured by one question which asked respondents: "*In your entire life did you ever attempt suicide*?" Respondents answered "Yes" (1) or "No" (0).

Demographic variables

Demographic risk variables included sex (Female = 0, Male = 1), socio-economic status ("below the median wage" = 0 and "on or above the median wage" = 1), ethnicity ("white" = 0, "non-white" = 1), and urbanicity ("non-urban dwelling" = 0, "urban dwelling" = 1).

Data analysis

The analytical strategy included three phases. First, confirmatory factor analysis (CFA) and confirmatory bifactor modelling (CBM) were used to determine the optimal latent structure of the 23 psychosis symptom indicators. Seven models derived from the literature were tested (Reininghaus et al., 2013; Shevlin et al., 2016). Model 1 was a unidimensional model of psychosis where the 23 items loaded onto a single general factor of psychosis. Model 2 was a correlated two-factor model of "Positive" and "Negative" symptoms. Model 3 was a correlated five-factor model of "Positive", "Negative", "Depression", "Mania", and "Disorganized" symptoms. Based on the extremely high correlation between the "Negative" and "Depressive" dimensions reported by Shevlin et al. (2016), a four-factor model was also tested wherein all items within these two dimensions were identified by a single "Negative" dimension (Model 4). Finally, Models 2, 3, and 4 were assessed within a bifactor framework where an uncorrelated general factor of psychosis was modelled in addition to the specific factors (Models 2b-4b). In the bifactor models, the specific factors were free to correlate with each other.

In phase two, the reliability and replicability of the dimensions within the best fitting model of psychosis were assessed using the indices advocated by Rodriguez et al. (2016). These included omega reliability (ω; the proportion of common variance explained by the general and specific factors), omega hierarchical (ωH; the proportion of variance within the individual symptom indicators attributable to the general [or specific] factor[s], controlling for the specific [or general] factors), the relative omega (ωR: calculated by dividing ωH by ω and representing the proportion of reliable variance due to the general factor independent of the specific factor, and each specific factor independent of the general factor), and index H (the extent to which a set of items represents a latent variable and the likelihood of that latent variable to replicate across studies). Omega coefficients and index H-values range from 0 to 1, where values closer to 1 suggest greater reliability and replicability of the latent variable. By convention, values greater than .80 on all indices reflect satisfactory reliability and replicability (Rodriguez et al., 2016). These indices were calculated using Dueber's (2017) calculator.

In the third phase, structural equation modelling (SEM) was used to determine the multivariate associations between each dimension of the best fitting model of psychosis and each risk factor (sex,

age, socio-economic status, ethnicity, urbanicity, total childhood interpersonal trauma, social support, and history of attempting suicide). The psychosis latent variables were represented as endogenous variables in the model and regressed onto the exogenous variables which were all entered as observed variables.

The factor analytic and SEM models were assessed in Mplus version 7.4 (Muthén & Muthén, 2012) using the weighted least squares means and variances adjusted (WLSMV) estimator (Flora & Curran, 2004). There was minimal missing data (3.9%) and this was handled using the default pairwise deletion method. The complex survey design of the NESARC-III was accounted for in all analyses by applying the "complex" analysis function in Mplus which adjusts for the weighting, stratification, and clustering of the survey design. Model fit was determined based on standard guidelines (Bollen, 1989; Hu & Bentler, 1999); a non-significant chi-square result; Comparative Fit Index (CFI) and Tucker–Lewis Index (TLI) values ≥ .90 and ≥ .95 indicating adequate and excellent fit, respectively; and Root-Mean-Square Error of Approximation (RMSEA) values ≤ .08 and ≤ .06 indicating adequate and excellent fit, respectively. Changes in the RMSEA (ΔRMSEA) were also compared as this index includes penalties for increasing model complexity. ΔRMSEA values > .015 are indicative of significant changes in the fit of the respective models (Chen et al., 2008).

Results

Descriptive statistics

The prevalence rates of psychotic symptoms ranged from 0.5% (e.g., hallucinations) to 20.1% (e.g., disturbance of volition). Prevalence rates of psychotic symptoms in this sample are presented in Supplementary Table 1. The majority of the sample was female (56.3%), of white ethnicity (52.9%), earning below the median wage (62.1%), and living in an urban environment (83.2%) see Table 1 for further details. The most commonly reported form of childhood interpersonal trauma was emotional neglect (53.3%), followed by emotional abuse (43.4%), physical abuse (35.4%), physical neglect (34.4%), and sexual abuse (11.5%). A quarter of the sample did not experience childhood interpersonal trauma (25.2%). A minority of the sample had attempted suicide (5.5%). Levels of perceived social support were high, on average (M = 10.46; SD = 2.10).

The latent structure of psychosis

The model fit results are presented in Table 2. Model 1, the unidimensional model of psychosis, yielded a good model fit. The correlated two-, four-, and five-factor models also fit the data very well and based on the ΔRMSEA results there was no significant improvement in model fit between the unidimensional and multidimensional models of psychosis. The bifactor models (Models 2b-4b) fit the data closely and were statistically superior to the unidimensional and multidimensional models (all ΔRMSEA values were > .015).

The bifactor pentagonal model (Model 3b) fit the data well; however, as with Shevlin et al.'s (2016) findings, a high correlation was found between the "Negative" and "Depression" dimensions (r = .95). Model 4b, which combines these two factors, was statistically indistinguishable from the bifactor pentagonal model. On the grounds of model parsimony and avoiding issues related to lack of discriminant validity between these dimensions in the SEM analysis, we selected Model 4b to be the best representation of the latent structure of the psychosis symptoms in this sample.

The factor loadings and factor correlations for Model 4b are presented in Table 3. The 23 psychosis symptoms loaded positively, significantly (p < .001), and robustly (mean factor loading = .67) on the general psychosis dimension. In relation to the specific dimensions, the six "Positive" symptoms loaded positively and significantly (p < .001) onto this dimension with a mean factor loading of .40. Ten of the eleven "Negative" symptoms loaded onto this dimension positively and significantly (p < .001) with a mean factor loading of .51. The three "Mania" symptoms

Table 2. Model fit results for the alternative models of psychosis (N = 36,309).

	χ^2	df	CFI	TLI	RMSEA 90% CI
Model 1	10,192.82*	230	.955	.951	.035 (.034-.035)
Model 2	9043.98*	229	.960	.956	.033 (.032-.033)
Model 2b	1078.67*	206	.996	.995	.011 (.010-.011)
Model 3	5968.70*	220	.974	.970	.027 (.026-.027)
Model 3b	783.84*	197	.997	.997	.009 (.008-.010)
Model 4	7636.78*	224	.967	.962	.030 (.030-.031)
Model 4b	**890.36***	**201**	**.997**	**.996**	**.010 (.009-.010)**

Note: χ^2 = chi-square goodness of fit statistic; df = degrees of freedom; RMSEA = Root-Mean-Square Error of Approximation with 90% Confidence Intervals; CFI = Comparative Fit Index; TLI = Tucker–Lewis Index. *Indicates χ^2 are statistically significant ($p < 0.001$). Best fitting model is in bold.

Table 3. Standardized factor loadings (and standard errors) and factor correlations for Model 4b.

	General	Positive	Negative	Mania	Disorganisation
Delusions	.68(.02)	.47(.05)			
Hallucinations	.66(.03)	.44(.05)			
Grandiosity	.59(.02)	.55(.05)			
Suspiciousness	.80(.01)	.35(.03)			
Unusual thought content 1	.85(.01)	.13(.04)			
Unusual thought content 2	.70(.02)	.46(.04)			
Blunted affect	.75(.01)		.10(.02)		
Emotional withdrawal	.83(.01)		.28(.02)		
Poor rapport	.80(.01)		−.01(.03)		
Motor retardation	.45(.02)		.72(.01)		
Disturbance of volition	.46(.02)		.84(.01)		
Active social avoidance	.61(.02)		.36(.02)		
Passive social withdrawal	.82(.01)		.15(.02)		
Depression	.51(.02)		.78(.02)		
Guilt	.46(.02)		.80(.01)		
Tension	.47(.02)		.79(.01)		
Anxiety	.48(.02)		.83(.01)		
Excitement	.52(.02)			.54(.04)	
Hostility	.72(.01)			.33(.03)	
Impulsivity	.74(.01)			.29(.03)	
Concept disorganization 1	.82(.01)				.26(.06)
Concept disorganization 2	.88(.01)				.18(.04)
Mannerisms and posturing	.83(.02)				.33(.06)
Factor Correlations					
Positive			.25(.05)	.37(.07)	.23(.10)
Negative				.47(.04)	.27(.07)
Mania					−.04(.11)
Disorganization					
Reliability and Replicability					
ω	.65	.06	.24	.03	.01
ωH	.84	.22	.41	.21	.08
ωR	.85	.24	.42	.26	.09
H	.97	.58	.92	.39	.19

Note: All correlations are statistically significant (p <.001) with the exceptions of "Poor rapport" with the negative factor and the mania factor with the disorganization factor.

loaded positively and significantly ($p < .001$) onto this dimension with a mean factor loading of .39. Finally, the three "Disorganization" symptom items loaded positively and significantly ($p < .001$) onto this dimension with a mean factor loading of .26. The correlations between the four specific dimensions ranged from .23 ("Disorganisation" and "Negative") to .47 ("Negative" and "Mania"). The "Disorganisation" and "Mania" dimensions were not significantly correlated.

Table 4. Standardized regression coefficients from structural equation modelling results.

	General R^2 = 19%	Positive R^2 = 7%	Negative R^2 = 13%	Mania R^2 = 7%	Disorganisation R^2 = 10%
Age	−.18(.01)***	.13(.03)***	.01(.01)	−.09(.03)**	.24(.05)***
Sex	.08(.01)***	−.05(.03)	−.22(.01)***	.12(.02)***	−.09(.05)
Income	−.06(.01)***	−.13(.03)***	.00(.01)	−.08(.03)**	−.11(.05)*
Urbanicity	−.01(.02)	−.05(.03)	.01(.01)	−.02(.03)	−.03(.06)
Ethnicity	−.05(.01)***	.18(.03)***	−.13(.01)***	−.01(.02)	.15(.04)**
Childhood interpersonal trauma	.24(.01)***	.01(.03)	.11(.01)***	.12(.02)***	−.11(.04)*
Social support	−.18(.01)***	.03(.02)	−.02(.01)	.07(.02)**	.05(.04)
Suicide attempt	.13(.01)***	.07(.02)***	.17(.02)***	.14(.02)***	.02(.03)

Note: Statistical significance = *p <.05, **p <.01, ***p <.001.

Reliability and replicability of the psychosis dimensions

The reliability and replicability indices for each dimension from Model 4b are presented in Table 3. The general dimension explained 84% of the reliable item variance, controlling for the specific dimensions (ωR = .84). The "Positive" (ωR = .24), "Negative" (ωR = .42), "Mania" (ωR = .26), and "Disorganized" (ωR = .09) specific dimensions did not explain a satisfactory level of reliable item variance, controlling for the general dimension. High H values for the "General" and "Negative" dimensions indicated that they were well-defined latent variables. However, satisfactory H values were not observed for the "Positive", "Mania", and "Disorganized" dimensions, indicating that they may lack construct replicability.

Psychosis dimensions and risk variables

The SEM model of psychosis provided an excellent fit of the data (χ^2 (345) = 1120.67, p < .001; CFI = .994; TLI = .992; RMSEA = .008 [95% CI = .008–.009]), and explained 19% of variance in the general psychosis dimension, 7% of the variance in the "Positive" dimension, 13% of variance in the "Negative" dimension, 7% of variance in the "Mania" dimension, and 10% of variance in the "Disorganized" dimension (all *ps* < .001). The multivariate associations between the risk variables and the general and specific dimensions of psychosis are reported in Table 4.

The general dimension of psychosis was most strongly associated with higher levels of childhood interpersonal trauma. It was also significantly associated with younger age, diminished social support, history of attempted suicide, being male, lower socio-economic status, and majority ethnic status. The "Positive" dimension of psychosis was most strongly associated with minority ethnic status and was also significantly associated with lower socio-economic status, older age, and history of attempted suicide. The "Negative" dimension was most strongly associated with being female and was also significantly associated with a history of attempted suicide, majority ethnic status, and childhood interpersonal trauma. The "Mania" dimension was most strongly associated with a history of attempted suicide and was also significantly associated with being male, childhood interpersonal trauma, younger age, lower socio-economic status, and increased social support. Finally, the "Disorganized" dimension was most strongly associated with older age, and was also significantly associated with minority ethnic status, lower socio-economic status, and was negatively associated with childhood interpersonal trauma.

Discussion

In this study, we set out to evaluate the validity of the bifactorial pentagonal model of psychosis within a nationally representative sample of the US. adult population. Our results showed that (1) a bifactor model with one "General" dimension of psychosis along with four correlated specific dimensions – reflecting "Positive", "Negative", "Mania", and "Disorganized" symptoms – was the best representation of the latent structure of psychosis; (2) the general dimension of psychosis had

excellent construct reliability and replicability whereas all of the specific dimensions, with the exception of the Negative dimension, did not; (3) the general dimension of psychosis was correlated with multiple external risk variables and the strongest of these was with childhood interpersonal traumas; and (4) the specific dimensions of psychosis were correlated with multiple external risk variables; however, these associations were generally weaker than their corresponding associations with the general dimension of psychosis.

Our primary goal was to determine if the bifactor pentagonal model identified by Shevlin et al. (2016) in the NESARC-II survey could be replicated in the NESARC-III survey. Our results were consistent with Shevlin et al.'s in that this model fits the data extremely well, and we also observed an exceptionally high correlation between the "Negative" and "Depression" dimensions. This finding undermined the discriminant validity of these dimensions; thus, we favoured a bifactor model with four specific dimensions where all of the indicators of the "Negative" and "Depressive" symptoms loaded onto one dimension. While we acknowledge that there may be valid clinical and research reasons to retain a distinction between these dimensions, we selected the four-factor bifactor model for several reasons. First, as previously mentioned, the correlation of r = .95 between the "Negative" and "Depression" dimensions made it extremely difficult to interpret these as meaningfully separate constructs. Secondly, we sought to extend the findings of Shevlin et al. by examining how the general and specific dimensions of psychosis correlated with a host of risk variables. When the bifactor model with five specific dimensions was tested in an SEM framework, the model would not converge due to the correlation between the "Negative" and "Depression" dimensions. Thus, while the bifactor pentagonal model fits the data extremely well in a measurement model, it was not interpretable within a structural model. As the more parsimonious four-factor bifactor model performed well in the measurement and structural models, we felt confident in selecting it as the optimal representation of psychosis within this sample. We wish to stress, however, that our findings do not invalidate the bifactor pentagonal model of psychosis, nor do they necessarily undermine the validity of the distinction between the "Negative" and "Depression" dimensions of psychosis, in general. The lack of distinctiveness between these dimensions in our analyses – and those by Shevlin et al. – may be due to the methodological limitations associated with using the NESARC datasets. Many of the indicators of the "Negative" and "Depression" dimensions were drawn from the same section of the AUDADIS-5; therefore, a method effect (i.e., item order effects) may have been the cause of the high correlation between these dimensions. In addition, as mentioned by Shevlin et al. a lack of clinical observation may have restricted the range of information related to some negative items. Nonetheless, our results add to previous findings demonstrating that a general dimension of psychosis is identifiable in both general population and clinical samples (Quattrone et al., 2019; Reininghaus et al., 2016, 2013; Shevlin et al., 2016).

The general dimension of psychosis possessed excellent construct reliability and replicability in this sample, while the specific dimensions – with the exception of the "Negative" dimension – had poor construct reliability and replicability. These findings are in contrast to recent research findings from clinical samples which found that the general and specific dimensions possessed acceptable construct reliability and replicability (Quattrone et al., 2019; Reininghaus et al., 2019). Previous data have indicated that the general dimension of psychosis may be more pronounced in the early stages of psychosis (e.g., first episode vs enduring psychosis) (Reininghaus et al., 2013). Moreover, the current study was the first to assess the construct reliability and replicability of the general and specific dimensions of psychosis in a general population sample. One possible explanation for the discrepant findings from clinical and community samples is that the commonly described clinical features of psychotic illness (i.e., positive and disorganized symptoms, in particular) do not become manifestly distinct from general psychosis until the illness progresses in severity.

The SEM results showed that the selected risk variables had quite unique associations with the general and specific dimensions of psychosis. Only two variables, lower socio-economic status and history of attempted suicide displayed a consistent pattern of association with the general and specific dimensions of psychosis. This suggested that these two variables, in particular, may have operated as risk factors for all types of psychotic symptoms. Other risk variables had differential associations with

general and specific dimensions. For example, younger age was associated with higher scores on the general dimension and the "Mania" dimension, whereas older age was associated with higher scores on the "Positive" and "Disorganized" dimensions. Consistent with previous research, ethnic minority status (i.e., non-white US citizens) was associated with higher scores on the "Positive" and "Disorganized" dimensions (Bourque et al., 2011; Cantor-Graae & Selten, 2005; Castillejos et al., 2018; Leaune et al., 2019; van Os et al., 2010); however, in contrast to recent findings, ethnic majority status (i.e., white US citizens) was associated with higher scores on the general psychosis dimension (Quattrone et al., 2019; Reininghaus et al., 2019). Additionally, males had higher scores on the general and "Mania" dimensions, whereas females had higher scores on the "Negative" dimension. Unsurprisingly, lower levels of social support were correlated with higher scores on the general dimension, while social support was positively correlated with the "Mania" dimension. Finally, childhood interpersonal trauma was positively associated with the general, "Negative", and "Mania" dimensions, and negatively associated with the "Disorganized" dimension. Taken together, these findings suggest that modelling the latent structure of psychosis as a bifactor model provides a more in-depth understanding of how risk factors are related to different aspects of psychosis.

The current findings should be interpreted in light of a number of relevant limitations. First, the AUDADIS-5 was used in NESARC-III meaning that our indicators of psychosis did not perfectly align with those selected by Shevlin et al. (2016) from the AUDADIS-IV. Second, the absence of detail regarding the timing of symptom onset makes it impossible to ascertain the chronology of the psychotic symptoms in this sample. Third, as these findings were based on a representative sample of the US, it is unknown if these results will generalize to culturally distinct populations. Replication in non-English speaking countries would be especially beneficial. Finally, the cross-sectional nature of the data precluded any inferences about the causal relationship between the risk factors and the different dimensions of psychosis. Future work using longitudinal data will help to elucidate the direction of these effects.

Conclusion

This study provides novel empirical support for the validity of a dimensional representation of the structure of psychosis in the general population. Once again, evidence emerged of a general dimension of psychosis encompassing both affective and non-affective psychotic symptoms. This general dimension of psychosis was shown to be a reliable and valid construct in the general population, and was most strongly associated with exposure to interpersonal traumas in early life. Although the specific dimensions, with the exception of the "Negative" dimension, lacked adequate reliability and replicability, they were associated with several risk variables suggesting that they do have conceptual meaning beyond the general dimension of psychosis within general population samples.

Disclosure statement

No potential conflict of interest was reported by the authors.

Funding

This work was supported by the Irish Research Council [GOIPG/2018/319].

ORCID

Frédérique Vallières http://orcid.org/0000-0001-6315-3029
Jamie Murphy http://orcid.org/0000-0003-1821-0025
Philip Hyland http://orcid.org/0000-0002-9574-7128

References

Bernstein, D. P., Fink, L., Handelsman, L., Foote, J., & Ruggiero, J. (1994). Initial reliability and validity of a new retrospective measure of child abuse and neglect. *The American Journal of Psychiatry*, *151*(8), 1132–1136. https://doi.org/10.1176/ajp.151.8.1132

Bollen, K. A. (1989). *Structural equations with latent variables*. JohnWiley &Sons.

Bonoldi, I., Simeone, E., Rocchetti, M., Codjoe, L., Fusar-Poli, P., Gambi, F., Balottin, U., Caverzasi, E., Politi, P., & Fusar-Poli, P. (2013). Prevalence of self-reported childhood abuse in psychosis: A meta-analysis of retrospective studies. *Psychiatry Research*, *210*(1), 8–15. https://doi.org/10.1016/j.psychres.2013.05.003

Bourque, F., van der Ven, E., & Malla, A. (2011). A meta-analysis of the risk for psychotic disorders among first- and second-generation immigrants. *Psychological Medicine*, *41*(5), 897–910. https://doi.org/10.1017/S0033291710001406

Cantor-Graae, E., & Selten, J. P. (2005). Schizophrenia and migration: A meta-analysis and review. *American Journal of Psychiatry*, *162*(1), 12–24. https://doi.org/10.1176/appi.ajp.162.1.12

Castillejos, M. C., Martín-Pérez, C., & Moreno-Küstner, B. (2018). A systematic review and meta-analysis of the incidence of psychotic disorders: The distribution of rates and the influence of gender, urbanicity, immigration and socio-economic level. *Psychological Medicine*, *48*(13), 2101–2115. https://doi.org/10.1017/S0033291718000235

Chen, F., Curran, P. J., Bollen, K. A., Kirby, J., & Paxton, P. (2008). An empirical evaluation of the use of fixed cutoff points in RMSEA test statistic in structural equation models. *Sociological Methods & Research*, *36*(4), 462–494. https://doi.org/doi.10.1177/0049124108314720

Crush, E., Arseneault, L., Moffitt, T. E., Danese, A., Fisher, H. L., Jaffee, S. R., Matthews, T., & Fisher, H. L. (2018). Protective factors for psychotic experiences amongst adolescents exposed to multiple forms of victimization. *Journal of Psychiatric Research*, *104*, 32–38. https://doi.org/10.1016/j.jpsychires.2018.06.011

Dong, M., Anda, R. F., Dube, S. R., Giles, W. H., & Felitti, V. J. (2003). The relationship of exposure to childhood sexual abuse to other forms of abuse, neglect, and household dysfunction during childhood. *Child Abuse & Neglect*, *27*(6), 625–639. https://doi.org/10.1016/S0145-2134(03)00105-4

Dube, S. R., Felitti, V. J., Dong, M., Chapman, D. P., Anda, R. F., & Anda, R. F. (2003). Childhood abuse, neglect, and household dysfunction and the risk of illicit drug use: The adverse childhood experiences study. *Pediatrics*, *111*(3), 564–572. https://doi.org/10.1542/peds.111.3.564

Dueber, D. M. (2017). *Bifactor indices calculator: A microsoft excel-based tool to calculate various indices relevant to bifactor CFA models*. https://doi.org/10.13023/edp.tool.01

Flora, D. B., & Curran, P. J. (2004). An empirical evaluation of alternative methods of estimation for confirmatory factor analysis with ordinal data. *Psychological Methods*, *9*(4), 466. https://doi.org/10.1037/1082-989X.9.4.466

Fusar-Poli, P., Tantardini, M., De Simone, S., Ramella-Cravaro, V., Galderisi, S., Kingdon, J., Kotlicka-Antczak, M., Valmaggia, L., Lee, J., Millan, M. J., Galderisi, S., Balottin, U., Ricca, V., & McGuire, P. (2017). Deconstructing Vulnerability for Psychosis: Meta-Analysis of Environmental Risk Factors for Psychosis in Subjects at Ultra High-Risk. *European Psychiatry*, *40*, 65–75. https://doi.org/10.1016/j.eurpsy.2016.09.003

Gayer-Anderson, C., & Morgan, C. (2013). Social networks, support and early psychosis: A systematic review. *Epidemiology and Psychiatric Sciences*, *22*(2), 131–146. https://doi.org/10.1017/S2045796012000406

Grant, B. F., Amsbary, M., Chu, A., Sigman, R., & Chou, P. S. (2014). *Source and accuracy statement: National epidemiologic survey on alcohol and related conditions-III (NESARC-III)* (pp. 1–125). National Institute on Alcohol Abuse andAlcoholism.

Grant, B. F., & Dawson, D. (2000). *The Alcohol Use Disorder and Associated Disabilities Interview Schedule-IV (AUDADIS-IV)* (pp. 54). National Institute on Alcohol Abuse and Alcoholism.

Grant, B. F., Dawson, D. A., Stinson, F. S., Chou, P. S., & Pickering, R. (2003). The AlcoholUse Disorder and Associated Disabilities Interview Schedule-IV (AUDADIS-IV): Reliability of alcohol consumption, tobacco use, family history of depression and psychiatric diagnostic modules in a general population sample. *Drug and Alcohol dependence*, *71*(1), 7–16. https://doi.org/10.1016/s0376-8716(03)00070

Grant, B. F., Goldstein, R. B., Chou, S. P., Saha, T. D., & Aivadyan, C. (2011). *The alcohol-use disorder and associated disabilities interview schedule-diagnostic and statistical manual of mental disorders, version (AUDADIS-5)*. National Institute on Alcohol Abuse and Alcoholism.

Grant, B. F., Goldstein, R. B., Smith, S. M., Jung, J., Aivadyan, C., Chou, S. P., Pickering, R. P., Ruan, W. J., Huang, B., Saha, T. D., Aivadyan, C., Greenstein, E., & Hasin, D. S. (2015). The Alcohol Use Disorder and Associated Disabilities Interview Schedule-5 (AUDADIS-5): Reliability of substance use and psychiatric disorder modules in a general population sample. *Drug and Alcohol Dependence*, *148*, 27–33. https://doi.org/10.1016/j.drugalcdep.2014.11.026

Greene, A. L., Eaton, N. R., Li, K., Forbes, M. K., & Fried, E. I. (2019). Are fit indices used to test psychopathology structure biased? A simulation study. *Journal of Abnormal psychology*, *128*(7), 740. https://doi.org/10.1016/j.cpr.2012.10.004

Hasin, D. S., Greenstein, E., Aivadyan, C., Stohl, M., Grant, B. F., Saha, T., Goldstein, R., Nunes, E. V., Jung, J., Zhang, H., & Grant, B. F. (2015). The Alcohol Use Disorder and Associated Disabilities Interview Schedule-5 (AUDADIS-5): Procedural validity of substance use disorders modules through clinical re-appraisal in a general population sample. *Drug and Alcohol Dependence*, *148*, 40–46. https://doi.org/10.1016/j.drugalcdep.2014.12.011

Hengartner, M. P., & Lehmann, S. N. (2017). Why psychiatric research must abandon traditional diagnostic classification and adopt a fully dimensional scope: Two solutions to a persistent problem. *Frontiers in Psychiatry*, *8*, 101. https://doi.org/10.3389/fpsyt.2017.00101

Hu, L. T., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling: A Multidisciplinary Journal*, *6*(1), 1–55. https://doi.org/10.1080/10705519909540118

Kay, S. R., Fiszbein, A., & Opler, L. A. (1987). The positive and negative syndrome scale(PANSS) for schizophrenia. *Schizophrenia Bulletin*, *13*(2), 261–276. https://doi.org/10.1093/schbul/13.2.261

Kotov, R., Krueger, R. F., & Watson, D. (2018). A paradigm shift in psychiatric classification: The Hierarchical Taxonomy Of Psychopathology (HiTOP). *WorldPsychiatry*, *17*(1), 24. https://doi.org/10.1002/wps.20478

Leaune, E., Dealberto, M. J., Luck, D., Grot, S., Brunelin, J., Poulet, E., & Brunelin, J. (2019). Ethnic minority position and migrant status as risk factors for psychotic symptoms in the general population: A meta-analysis. *Psychological Medicine*, *49*(4), 545–558. https://doi.org/10.1017/S0033291718002271

Murphy, J., Shevlin, M., Hyland, P., Christoffersen, M., Bentall, R., & Bentall, R. (2018). Reconsidering the association between psychosis and suicide: A suicidal drive hypothesis. *Psychosis*, *10*(4), 286–297. https://doi.org/10.1080/17522439.2018.1522541

Muthén, L. K., & Muthén, B. O. (2012). *MPlus: Statistical analysis with latent variables. User's guide*. Los Angeles, CA: Muthén & Muthén.

Potuzak, M., Ravichandran, C., Lewandowski, K. E., Ongür, D., & Cohen, B. M. (2012). Categorical vs dimensional classifications of psychotic disorders. *Comprehensive psychiatry*, *53*(8), 1118–1129. https://doi.org/10.1016/j.comppsych.2012.04.010

Quattrone, D., Di Forti, M., Gayer-Anderson, C., Ferraro, L., Jongsma, H. E., Szöke, A., La Cascia, C., La Barbera, D., Tarricone, I., Berardi, D., Szöke, A., Arango, C., Lasalvia, A., Tortelli, A., Llorca, P.-M., de Haan, L., Velthorst, E., Bobes, J., Bernardo, M., Sanjuán, J., & Reininghaus, U. (2019). Transdiagnostic dimensions of psychopathology at first episode psychosis: Findings from the multinational EU-GEI study. *Psychological Medicine*, *49*(8), 1378–1391. https://doi.org/10.1017/S0033291718002131

Reininghaus, U., Böhnke, J. R., Chavez-Baldini, U., Gibbons, R., Tamminga, C. A., Clementz, B. A., Pearlson, G. D., Keshavan, M. S., Sweeney, J. A., & Tamminga, C. A. (2019). Transdiagnostic dimensions of psychosis in the Bipolar-Schizophrenia Network on Intermediate Phenotypes (B-SNIP). *World Psychiatry*, *18*(1), 67–76. https://doi.org/10.1002/wps.20607

Reininghaus, U., Böhnke, J. R., Hosang, G., Farmer, A., Bentall, R. P., McGuffin, P., & Bentall, R. P. (2016). Evaluation of the validity and utility of a transdiagnostic psychosis dimension encompassing schizophrenia and bipolar disorder. *British Journal of Psychiatry*, *209*(2), 107–113. https://doi.org/10.1192/bjp.bp.115.167882

Reininghaus, U., Priebe, S., & Bentall, R. P. (2013). Testing the psychopathology of psychosis: Evidence for a general psychosis dimension. *Schizophrenia bulletin*, *39*(4), 884–895. https://doi.org/10.1093/schbul/sbr182

Rodriguez, A., Reise, S. P., & Haviland, M. G. (2016). Applying bifactor statistical indices in the evaluation of psychological measures. *Journal of Personality assessment*, *98*(3), 223–237. https://doi.org/10.1080/00223891.2015.1089249

Ruan, W. J., Goldstein, R. B., Chou, S. P., Smith, S. M., Grant, B. F., Pickering, R. P., Dawson, D. A., Huang, B., Stinson, F. S., & Grant, B. F. (2008). The Alcohol Use Disorder and Associated Disabilities Interview Schedule-IV (AUDADIS-IV): Reliability of new psychiatric diagnostic modules and risk factors in a general population sample. *Drug and Alcohol Dependence*, *92*(1–3), 27–36. https://doi.org/10.1016/j.drugalcdep.2007.06.001

Shevlin, M., McElroy, E., Bentall, R. P., Reininghaus, U., & Murphy, J. (2016). The psychosis continuum: Testing a bifactor model of psychosis in a general population sample. *Schizophrenia Bulletin*, *43*(1), 133–141. https://doi.org/10.1093/schbul/sbw067

Straus, M. A. (1979). Measuring intrafamily violence and conflict: The Conflict Tactics (CT)scale. *Journal of Marriage and Family*, *41*(1), 75–88. https://doi.org/10.2307/351733

Straus, M. A., Hamby, S. L., Boney-McCoy, S., & Sugarman, D. B. (1996). The revised conflict tactics scales (CTS2) development and preliminary psychometric data. *Journal of Family Issues*, *17*(3), 283–316. https://doi.org/10.1177/019251396017003001

van Os, J., Kenis, G., & Rutten, B. P. (2010). The environment and schizophrenia. *Nature*, *468*(7321), 203–212. https://doi.org/10.1038/nature09563

Varese, F., Smeets, F., Drukker, M., Lieverse, R., Bentall, R. P., Viechtbauer, W., Read, J., van Os, J., & Bentall, R. P. (2012). Childhood adversities increase the risk of psychosis: A meta-analysis of patient-control, prospective- and cross-sectional cohort studies. *Schizophrenia Bulletin*, *38*(4), 661–671. https://doi.org/10.1093/schbul/sbs050

Widiger, T. A., & Gore, W. L. (2014). Dimensional versus categorical models of psychopathology. *The Encyclopedia of Clinical Psychology*, 1–12. https://doi.org/10.1002/9781118625392.wbecp108